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This paper explores the role of edges in defining prominence patterns of phrases and compounds in the framework of Optimality Theory. As has been observed in rule-based theories (cf. Visch 1989; *forthc.*), there is a strong preference for the periphery as the target of rhythmic adjustment rules, like Move x and Add x. These rules function to strengthen (morpho-syntactic) constituent boundaries, to obtain more distance between prominence peaks in a domain, even creating clashing situations. This preference for the periphery is the cornerstone of the constraint-based approach of prominence patterns above word level that will be defended in this paper and which is based on the first attempt to analyze phrasal patterns in terms of the constraints proposed by Selkirk (1995). A key role is attributed to a constraint EdgeLeft which states that a left-peripheral subconstituent in a phrasal domain is always more prominent than an internal subconstituent. This constraint captures more or less rhythmic alternation, but is more specific because it demands an adjacent phrase boundary. The line of argumentation proves its value when compound patterns in English and Dutch are taken into consideration. The difference in the position of main stress and differences in the rhythmic structure of compounds in English and Dutch can be attributed entirely to two mutually incompatible constraints. Whereas Dutch has EdgeRight, requiring that right-edge subconstituents be stressed, English has NON-FINALITY which explicitly excludes final stress. The interaction of these two constraints with the relevant alignment constraints in the language explains why Dutch compounds surface with initial main stress, whereas English is sensitive to branchingness in the compound. Moreover, the observation in rule-based analyses that rhythmic adjustment is only left-directional in English, but bidirectional in Dutch can be attributed to the central position that the constraint NON-FINALITY occupies in the grammar of English.\*

## 0. Introduction

There is extensive literature on rhythmic phenomena in metrical theory. It has been claimed that in general patterns of complex phrases and compounds are directly related to the patterns of simplex embedded phrases, compounds and words, i.e. relative prominence is preserved under embedding. Main stresses of embedded words are anchorpoints of both primary and non-primary stresses of compounds and phrases.

However, this tendency to preserve prominence under embedding can be disturbed by the influence of rhythm, causing "shift" of stresses or "strengthening" of stresses. In a rule-based analysis, rules like Move x or Add x are used to achieve more alternating patterns, sometimes overruling word stresses and nuclear stresses.

It has been claimed that these adjustments are typically optional, judgements ranging in degree from "strongly preferred" to "quite unlikely". The situation is delicate, since the more complex the structures, the more subtle the differences between patterns. Interaction with other phenomena such as contrastive accent, focus or intonation must also be reckoned with.

In this paper, I will discuss the representation of compound and phrasal patterns and the influence of rhythmic effects within the framework of Optimality Theory (cf. Prince & Smolensky 1993; McCarthy & Prince 1993), ignoring largely the optionality of the phenomenon. I assume that the pattern that is considered to arise most likely within rule-based analyses is the pattern that OT must consider as the most optimal one. Within OT we can arrive at other output structures by assuming that other (overruling) factors interfere with the ordinary ones. I will not deal with this issue, however.

This article is organized as follows. In section 1, I will outline some essential characteristics of a rule-based analysis of rhythmic patterns to provide some background. Section 2 presents the first attempt of analyzing phrasal rhythmic patterns within a constraint-based theory, that proposed by Selkirk (1995). In section 3, I will show that the proposal of Selkirk (1995) "overgenerates", and I will modify the analysis in such a way that it is capable of selecting the correct candidate in more complicated phrases. In section 4, I will extend the analysis by showing that a constraint-based analysis can capture quite easily the differences in the stressing of compounds in English and Dutch. In section 5, I will outline some consequences of the approach adopted by examining some complex constructions in which compounds are embedded in phrases. Finally, I will wind up the discussion in section 6 with some concluding remarks.

### 1. Some characteristics of rhythmic phenomena in a rule-based framework

Some recent rule-based proposals (Halle & Vergnaud 1987; Hayes 1995; Visch forthc.) have in common that End Rules are held responsible for the assignment of higher-level prominences in bracketed grids and that morpho-syntactic bracketing provides the domains

where these End Rules apply. Sometimes, the concatenation of words in phrases or compounds results in non-optimal rhythmic configurations, i.e. clashes ("adjacent prominent positions") and lapses ("stretches of equally weak stresses"). These patterns can be improved by applying rules like Move x or Add x that create more alternating patterns, sometimes overruling word stresses or nuclear stresses. As an illustration, consider the examples in (1):

- (1) a.  $\begin{matrix} ( & . & * \\ ( & * & (*) \\ (*) & (*) & (*) \end{matrix}$  thirteen mén  
           Move x  $\rightarrow$   $\begin{matrix} ( & * \\ (*) & (*) \end{matrix}$  thirteen mén
- b.  $\begin{matrix} ( & * \\ ( & * \\ (*) & (*) \end{matrix}$  trois rêd shîrts  
           Add x  $\rightarrow$   $\begin{matrix} ( & * \\ (*) & (*) \end{matrix}$  trois rêd shîrts

In (1a), the position of word stress in *thirteen* is overruled by applying Move x; in (1b), more alternation is achieved by the addition of a gridmark on *three*.

There are two general principles that define well-formed structure within bracketed-grid theory.

- (2) a. FAITHFULNESS CONDITION (Hayes 1995:380)  
 Grid marks must be in one-to-one correspondence with domains of which they are heads.
- b. CONTINUOUS COLUMN CONSTRAINT (=CCC) (Hayes 1995:34)  
 A grid containing a column with a mark on layer  $n + 1$  and no mark on layer  $n$  is ill-formed. Phonological rules are blocked when they would create such a configuration.

Let us first consider the Faithfulness Condition (based on earlier work by Hammond 1984 and Halle & Vergnaud 1987). This condition requires that every gridmark be the head of some unique domain and that every domain have a unique head. It guarantees that more than minimal structure is created by the End Rules. Consider two possible structures in (3).

- (3) a. ( . \* ) b. ( . \* )  
 ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 [three [red shirts]] [three [red shirts]]

Although both structures express the fact that *shirts* bears primary stress, (3a) is "more optimal" than (3b) since it satisfies the Faithfulness Condition. Moreover, to achieve more alternation in a structure like (3b), we have to expand the grid with one layer to be able to add an extra gridmark. Therefore, the analysis of strengthening would be more complicated.

This richer type of representation is also needed to explain some non-applications of Move x, as illustrated in (4).

- (4) a. ( . \* ) ( . \* )  
 ( \* ) ( \* ) ( \* ) ( \* )  
 ( \* ) ( \* ) ( \* ) ( \* )  
 [[[Tom Paine]Street] Blúes] Tom Paine Street Blues  
 Move x ( \* ) ( \* )  
 -/-> ( \* ) ( \* ) ( \* ) ( \* )
- b. ( . \* ) ( . \* )  
 ( \* ) ( \* ) ( \* ) ( \* )  
 ( \* ) ( \* ) ( \* ) ( \* )  
 [[[Tom Paine]Street] Blúes] \*Tom Paine Street Blúes  
 Move x ( \* ) ( \* )  
 → ( \* ) ( \* ) ( \* ) ( \* )

In (4a), the higher column on *Paine* indirectly expresses the complexity of the structure. It enables us to explain straightforwardly that Move x in this type of structure is non-applicable. Every imaginable application of Move x would create a gap in a column, therefore, there is no possible landing site for the grid mark. The Continuous Column Constraint in (2b) (due to Prince 1983:33) ensures the immobility of the strong beat in (4a). In a structure like (4b), nothing would prevent movement, resulting in an ill-formed contour.

In Hayes (1995) and Visch (forthc.), input structures are non-exhaustively parsed. More distinctions are introduced by the application of adjustment rules like Add x (see (1b)). Non-exhaustive parsing is not completely self-evident, but I will refrain from discussing this issue here and refer the reader to Visch (forthc.) for a detailed motivation and choice of this type of analysis as opposed to others.

On the basis of a detailed investigation of increasingly complex structures in Visch (1989; forthc.), the following observation can be made with respect to rhythmic patterning in a rule-based analysis. There is a strong preference for the periphery as the target of rhythmic

mic adjustment rules above the word level. Add x and Move x function to strengthen (morpho-syntactic) boundaries, externally and internally, to obtain more distance between peaks in a domain ("rhythmic hammock"), possibly even creating clashing situations in the grid. Eurhythmic factors, i.e. "clashes" and "lapses", can be seen as influencing the likelihood of application of both Move x and Add x. Some patterns are less likely to occur than others simply because of the fact that they are less alternating. Still the preference of more differentiation at edges of domains prevails and can outrank alternation. This preference is difficult to capture formally in a rule-based theory.

In the next section, I will present a first attempt by Selkirk (1995) to express phrasal stress patterns within a constraint-based framework. It is striking that within Selkirk's proposal the preference of edges is made the cornerstone.

## 2. Selkirk (1995): The role of Phrase Edge Prominence

In Optimality Theory, only one candidate will surface as the most optimal candidate. Since no rules are available, the optimal candidate will be the most eurhythmic one that is available in the candidate set. This candidate will also have the most differentiated pattern, resulting in exhaustively parsed grids.

At least some well-formedness conditions of the rule-based analysis of section 1 translate easily in optimality terms. The Faithfulness Condition and the Continuous Column Constraint (without the reference to phonological rules, of course) can be considered as undominated constraints, i.e. they are inviolable. They take care of richly-structured grids without gaps.

A first informal attempt to translate generalizations with respect to higher level patterning in terms of constraints can be found in Selkirk (1995). She illustrates the effects of competing principles without making her claims completely explicit or going into detail. According to Selkirk, three aspects have to be accounted for: (i) the presence or absence of pitch accents; (ii) the position of main stress in a phrase, and (iii) the presence or absence of other prominent elements.

The position of primary stress within a phrase is covered by the informally stated Nuclear Stress Rule in (5), which must be interpreted as a constraint:

- (5) NUCLEAR STRESS RULE (=NSR) (Selkirk 1995:562)

The most prominent syllable of the rightmost constituent in a phrase P is the most prominent syllable of P.

As observed in Selkirk (1984), the effect of the NSR can be overruled by the presence of pitch accents. Consider for instance, a sentence like (6) where the pitch-accented syllable *book* is the most prominent syllable instead of *bats*.

- (6) Mary wrote a BOOK about bats

The relation between stress prominence and pitch accent can be expressed by the following constraint:

- (7) PITCH ACCENT PROMINENCE RULE (=PAPR) (Selkirk 1995:563)

A syllable associated to a pitch accent has greater stress prominence than a syllable which is not associated to a pitch accent.

The fact that the NSR can be violated implies that PAPR is ranked higher than the NSR: PAPR >> NSR. In (6), the NSR chooses *bats* as the most prominent element, whereas the PAPR chooses *books*. PAPR wins. Only in cases where PAPR and NSR do not conflict, does NSR take effect, i.e. in cases in which all words are accented or all are unaccented. I assume that in all the cases to be discussed in this article the latter is the case, i.e. the stressed syllables are unaccented.

In a constraint-based theory, rhythmic effects are expressed directly without the need for repair rules. As noted in section 1, edges are more favored positions to bear stress than internal positions in phrases. Selkirk comes to the same conclusion. She notes that a repeatedly observed fact with respect to word stress is that edge feet are more prominent than internal feet (*ápalâchicóla, chimpanzée*) and that this observation can be extended to higher level constituents. She proposes the following principle:

- (8) PHRASE EDGE PROMINENCE (=EDGE PROM) (Selkirk 1995:565)

The most prominent syllable of an edge constituent is more prominent than that of a constituent not located at an edge.

Notice that (8) does not mention any specific edge. At first sight, this seems to be an advantage because (8) can conflict with the NSR. To see this, consider the surface patterns in (9).

- (9) a. ( . \* ) b. ( . \* )  
 (\* ) ( . \* ) (\* ) ( \* )  
 (\* ) ( \* . ) ( \* ) (\* ) ( \* ) ( \* . )  
 Farrah Fawcett Majors Mary Ellen Mathers

In (9a), the NSR and EdgeProm conspire and are both satisfied: they pick out the same constituent as bearing the primary stress in the phrase. *Farrah* has been "promoted" to "secondary stress" since it is also an edge constituent. In (9b), however, there is a conflict between EdgeProm and NSR in the embedded phrase. EdgeProm overrules the NSR. We can express this by ranking EdgeProm higher than NSR: EdgeProm >> NSR. Again, as with the interaction of PAPR and NSR, the effect of NSR is only felt if EdgeProm and NSR converge.

The formulation of EdgeProm implies that we have to consider subconstituents that together constitute a higher-level domain. This can be made clear by considering the evaluation of other possible candidates.

- (10) a. ( . \* ) EdgeProm >> NSR  
 ( . \* ) ( \* ) \*!  
 ( \* ) ( \* ) ( \* . )  
 Mary Ellen Mathers
- b. ( . \* )  
 ( \* . ) ( \* ) \*  
 ( \* ) ( \* ) ( \* . )  
 Mary Ellen Mathers
- c. ( \* . )  
 ( \* . ) ( \* ) \*!  
 ( \* ) ( \* ) ( \* . )  
 Mary Ellen Mathers
- d. ( . \* . )  
 ( . \* ) ( \* ) \*!  
 ( \* ) ( \* ) ( \* . )  
 Mary Ellen Mathers

In the domain *Mary-Ellen Mathers*, there are three subconstituents. In (10a), the subconstituent *Mary*, which is lying at the edge of the phrase, is less prominent than the subconstituent *Ellen*, which can be considered an internal constituent with respect to the higher-level domain. Therefore, EdgeProm is violated. Since there are at least two candidates which do not violate EdgeProm, this violation is fatal. (10d) violates EdgeProm twice. Both *Mary* and *Mathers* are less prominent than the internal subconstituent *Ellen*. One of these violations is already fatal for this structure. Candidates (10b) and (10c)

both satisfy EdgeProm in all domains. Now the NSR becomes relevant. Although (10b) violates the NSR too, it is more optimal than (10c).

In right-branching phrases, too, we must consider subconstituents to see whether or not EdgeProm is satisfied in the larger phrase. In these cases, the subconstituents are not even sisters.

- (11) a.  $( (* ) ( * ) ( * ) )$  EdgeProm >> NSR  
 Farrah Fawcett Majors \*!  
 b.  $( (* ) ( * ) ( * ) )$  \*!  
 Farrah Fawcett Majors \*!  
 c.  $( ( * ) ( * ) ( * ) )$   
 Farrah Fawcett Majors  
 d.  $( ( * ) ( * ) ( * ) )$  \*!  
 Farrah Fawcett Majors \*\*

One violation of EdgeProm is enough to reject (11a). In structure (11d), two violations of EdgeProm are present: *Fawcett* is an internal constituent and this constituent is more prominent than both edge constituents. EdgeProm is satisfied in (11b) and (11c). Structure (11c) is the most optimal one, since it does not violate any constraint.

Finally, Selkirk observes that the fact that the NSR can be overruled by EdgeProm can immediately account for a contrast observed in the literature that is difficult to capture in rule-based analyses. Although it seems that in both examples of (12) no improvement can be made with respect to rhythmic alternation, shift can be applied in (12a) but not in (12b).

- (12) a.  $( ( * ) ( * ) ( * ) )$  b.  $( ( * ) ( * ) ( * ) )$   
 grèen bambôo tábles grèen bambôo tábles  
 \*grèen bambôo tábles  
 \*grèen bambôo tábles

Selkirk claims that EdgeProm is responsible for this difference. In (12a), "shift" to the syllable *bam-* will satisfy EdgeProm within the domain *bambooo tables*, whereas shift in (12b) will violate it, since *bam-* is an internal constituent within the domain *green bambooo*. Actually, there are two violations of EdgeProm in the "shifted" structure of (12b): *-boo* must be more prominent than *bam-*, and *green* must be more prominent than *bam-*. The constraint specifically demands that edge constituents must be *more* prominent than non-edge constituents, not equally prominent. Selkirk does not make this explicit.

In Prince (1983), it is suggested that shift in (12b) is blocked because it would introduce a clash within its own domain whereas this is not the case in (12a). However, as noted by Gussenhoven (1991), enlarging the number of syllables of the first word has no influence on the surface patterns. This type of structure generally resists adjustment. Therefore, the reason must be structural. EdgeProm covers this structural property by expressing that edges of domains are preferably stressed.<sup>1</sup>

What can be concluded then is that EdgeProm is evaluated within each domain separately and that EdgeProm can overrule the (set of) constraint(s) that is responsible for the position of primary word stress. I will informally refer to this set of constraints as MSR: EdgeProm >> MSR.

Finally, notice that all the patterns discussed thus far are considered to be the result of edge effects. No reference is made to constraints expressing rhythm, clash, lapse or alternation. As noted already by Hayes (1984), the notion of "clash" is not always sufficient to explain the occurrence of shift. In cases like *thirtèen mén* there is a clash but in a case like *thirtèen pontóons* there isn't, yet shift is performed in both cases. A constraint like EdgeProm covers both cases immediately and for the same reason. In the following sections, we will pursue this line and see whether or not this idea can be maintained.

### 3. EdgeLeft

#### 3.1. Phrase Edge Prominence revised

Before we proceed with some more complex phrases, let us consi-

der one unintended consequence of the analysis presented in the preceding section. It seems that EdgeProm with its reference to non-specific edges has too wide a scope. If EdgeProm can overrule main word stresses in cases like *thirteen men* and *[green [bamboo tables]]* then there is no way to exclude this also at the right edge of the phrase. We predict, for instance, that the most optimal candidate for *Chinese gymnast* is \**Chinese gymnást* (instead of *Chinese g'yumnast*), because *-nast* is a phrasal edge constituent.<sup>2</sup>

As noted in the (rule-based) literature, movement in phrases is strictly left-directional towards phrase boundaries. This seems to suggest that we have to refer to edge specifically. Let us assume that Phrasal EdgeProm is more explicitly formulated as follows:

- (13) EDGELEFT<sup>3</sup>  
 In a phrasal domain P a subconstituent adjacent to the left edge of P is more prominent than a subconstituent that is not adjacent to one of the edges of P.

The position of main stress in a word adjacent to the right edge of a phrase is solely determined by the set of constraints expressing word stress, as can be seen in (14).

- (14) EdgeLeft >> MSR , NSR
- |    |                   |     |   |
|----|-------------------|-----|---|
| a. | Chinese gymnást   | *!* |   |
| b. | Chinese g'yumnast | *   |   |
| c. | Chinèse g'yumnast | *!  |   |
| d. | Chínese g'yumnast | *   | * |
| e. | Chinése gymnast   | *!  | * |

The position of main stress in the rightmost word has nothing to do with EdgeLeft because the subconstituent *-nast* is not adjacent to the left edge of a phrase. The position of main stress in the word adjacent to the left edge of the phrase is crucially determined by EdgeLeft, rejecting (14c) and (14e). The MSR and the NSR together take care of selecting (14b) as the most optimal candidate. However, a ranking between these two constraints is difficult to establish since both rankings give the same result. The remaining three candidates violate at least one of the constraints. If NSR is ranked higher than MSR, (14d) is rejected first, having initial phrasal stress and the decision is made by MSR, which considers (14b) as the most optimal one. If MSR is ranked higher than NSR, (14a) is rejected having two violations of MSR. The decision is then made by NSR, which also favors (14b).

Finally, notice that we have assumed that grids are exhaustively parsed. Do we need a constraint from the PARSE-family to cover this? The answer seems to be no. Since EdgeLeft demands that left-edge constituents are always *more* prominent than non-edge constituents, it will consider (15a) as more optimal than (15b):

- (15) a. ( . \* ) b. ( . \* )  
 ( \* ) ( . \* ) ( . \* )  
 ( \* ) ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 grèen bâmboo tábles grèen bâmboo tábles

In (15b), both subconstituents *green* and *bamboo* of the phrase are equally prominent, therefore, this structure violates EdgeLeft and more differentiation is called for, as in (15a).

3.2. EdgeLeft in complex phrases

Although it is impossible within the limits of this paper to consider the whole range of facts, let us test this analysis with several more complex examples. In strictly right-branching structures, no extra constraints are needed to select the most differentiated candidate. Consider (16).

- (16) EdgeLeft >> NSR
- |    |                          |  |     |
|----|--------------------------|--|-----|
| a. | ( . * )                  |  |     |
|    | ( . * )                  |  |     |
|    | ( * ) ( * ) ( * )        |  |     |
|    | grèen bâmboo tábles      |  |     |
|    |                          |  | *!* |
|    | ( * ) ( * ) ( * ) ( * )  |  |     |
|    | Pèter's thrèe red shírts |  |     |
| b. | ( . * )                  |  |     |
|    | ( . * )                  |  |     |
|    | ( * ) ( . * )            |  |     |
|    | ( * ) ( * ) ( * ) ( * )  |  |     |
|    | Pèter's thrèe red shírts |  |     |
|    |                          |  | *!  |
| c. | ( . * )                  |  |     |
|    | ( . * )                  |  |     |
|    | ( * ) ( * ) ( . * )      |  |     |
|    | ( * ) ( * ) ( * ) ( * )  |  |     |
|    | Pèter's thrèe red shírts |  |     |
|    |                          |  | *!  |

		EdgeLeft	>>	NSR
d.	( ( * ) ( * ) ( * ) ( * ) Pèter's thrée red shirts			
e.	( * ) ( * ) ( * ) ( * ) Pèter's thrée rêd shirts	*!*		***

Within the domain *three red shirts*, the subconstituent *three* should be more prominent than *red* and within the larger domain, *Peter's* should be more prominent than *three (red shirts)* is itself an edge constituent). Therefore, we have two violations of EdgeLeft in (16a), one in (16b). Also (16c) violates EdgeLeft, because *Peter's* and *three* are equally prominent. In (16e), all edge constituents are stressed, but in every domain it is followed by an equally prominent non-edge constituent. Therefore, there are two violations of EdgeLeft. In fact, EdgeLeft prefers a stressed element to be followed by an unstressed one. This statement captures more or less rhythmic alternation, although it is more specific because it demands an adjacent phrase boundary. The only candidate that remains is (16d).

What seems to be problematic is that (16b) is also claimed to be possible, perfectly alternating, output. In a rule-based analysis, this can be attributed to the fact that Add x is optional and can apply freely wherever possible to create more alternation. As noted in Visch (1989), this contour might be favored by the presence of pitch accents. (16b) can be selected within OT if *three* is provided with a pitch accent. The PAPER which is ranked higher than EdgeLeft will prefer structure (16b) in that case, although the grid is not exhaustively parsed anymore. We have to appeal to this kind of overruling factors to be able to arrive at more than one surface pattern.

Now let us look at left-branching structures, as in (17).

(17) [[[[Mary-Èllen] Mâthers] 'T shirt] → Mâry-Ellen Mâthers  
 [[[[thirty-twô] twènty] blúes] → thirty-two twènty blúes

Within rule-based analyses, it was observed that in this type of structures shift must be applied in a specific order. A direct shift to

*Ellen* or *two* in the input pattern is ill-formed: \**Mary-èllen Mathers 'T-shirt, \*thirty-twò twenty blúes*. This contour could not formally be excluded, since Move x is an optional rule, creating alternation here. Visch (1989; forthc.) observed the boundary effect, although this could only be expressed by an explicit ordering of preference rules, which comes close to a constraint-based analysis. OT provides the necessary mechanism to make this observation formally expressable: in the preferred pattern, the constituent at the left edge of the entire domain is the most prominent one because all edges of all domains coincide. Consider the evaluation of some candidates in (18).

(18)		EdgeLeft	>>	NSR
a.	( ( . * ) ( * ) ( * ) ( * ) thirty two twenty blues	*!*		
b.	( ( . * ) ( * ) ( * ) ( * ) thirty two twenty blues	*!		*
c.	( ( * ) ( * ) ( * ) ( * ) thirty two twenty blues			**
d.	( ( * ) ( * ) ( * ) ( * ) thirty two twenty blues	*!		*

Structure (18a) violates EdgeLeft twice. In the phrase *thirty two twenty*, the subconstituent *two* one level down does not qualify as an edge constituent and yet it is more prominent than the edge subconstituent *thirty (twenty)* as an edge constituent is fine, of course). At the highest level in the grid the subconstituent *twenty* one level down is more prominent than the edge constituent *thirty two*: again a violation of EdgeLeft. In structure (18b), there is only one violation of EdgeLeft, i.e. at the highest level in the grid, the subconstituent

twenty one level down is more prominent than its sister *thirty-two* which is located at the left edge. In (18c), *EdgeLeft* is satisfied in all domains, although of course *NSR* is violated more than once. Finally, (18d) is ruled out again by *EdgeLeft*. Within the domain *thirty two* the subconstituent *thirty* is less prominent than the subconstituent *two* not lying at an edge. Notice that this analysis correctly rejects this structure, although there is perfect alternation of prominent and non-prominent elements.

Rhythmic phrasal patterning in Dutch is highly comparable to English, therefore, I will not discuss Dutch here. In the next section, however, I will discuss the patterns of compounds in both English and Dutch, because these two languages crucially differ in this area.

#### 4. *Compounds: EdgeRight versus NON-FINALITY*

In this section, it will be made clear that most of the differences in prominence patterns of compounds in Dutch and English can be attributed to two mutually incompatible constraints.

As has been observed, there are at least two differences between English and Dutch with respect to the surface prominence patterns of compounds. First of all, where as Dutch has strictly initial compound stress, the stressing in English seems to depend on branchingness of the structure. Consider the position of main stress in the following examples.

- |      |    |                        |                        |
|------|----|------------------------|------------------------|
| (19) | a. | [[vóet bal] veld]      | [bád [hand doek]]      |
|      |    | “foot ball field”      | bath hand cloth        |
|      |    |                        | “bath towel”           |
|      | b. | [[kítchen towel] rack] | [kítchen [tówel rack]] |

In Dutch, both left- and right-branching compounds have initial main stress, whereas in English, left-branching structures have initial stress, but right-branching ones have main stress on the (rightmost) constituent that branches.

This is not the only difference between Dutch and English. It has been claimed in the literature (cf. among others Kager & Visch 1988; Hayes 1984) that English compound patterns are less differentiated than Dutch compound patterns. In Dutch, shift and strengthening can occur in compounds, whereas this is excluded in English. Because of the position of main stress, the circumstances for shift do not occur in English compounds such as (19b). But strengthening

does not occur either: flattened patterns seem preferable. Compare the examples in (20).

- |      |    |                       |      |                        |                   |
|------|----|-----------------------|------|------------------------|-------------------|
| (20) | a. | [bád [hând dôek]]     | →    | [bád [hând dôek]]      | “bath towel”      |
|      | b. | [[vóet bà] vèld]      | →    | [[vóet bál] vèld]      | “foot ball field” |
|      |    | [[ápple juice] bôard] | -/-> | *[[ápple júice] bôard] |                   |

As argued for in Visch (1989; forthc.), boundaries play a role in Dutch compounds, with peaks as far apart as possible, disturbing compound stresses in embedded constituents. Moreover, the main stress of words can be overruled in Dutch by preferring the right edge of the compound. In English, this is not allowed, as can be seen in (21).

- |      |    |               |      |               |                |
|------|----|---------------|------|---------------|----------------|
| (21) | a. | kléur pòtlood | →    | kléur pòtlood | “color pencil” |
|      | b. | láv library   | -/-> | *láv libràry  |                |

Finally, if compounds are embedded in phrases, compounds behave as if they were islands. We find the same patterns as in isolation:

- |      |    |                      |   |                             |
|------|----|----------------------|---|-----------------------------|
| (22) | a. | láv library          | - | láv libràry néwsletter      |
|      | b. | spòrt lief hèbber    | - | spòrt lief hèbber Sméets    |
|      |    | spòrt love possessor |   | spòrt love possessor (name) |
|      |    | “sport lover”        |   | “sport lover Sméets”        |

In the Dutch compound in (22b), shift is applied overruling the initial compound stress in the embedded compound in favor of the right edge of the compound.

With this in mind, let us see how the patterning of compounds can be handled within OT. Of course, it is crucial that constraints expressing the position of stress in compounds must know that they are compounds, just like the *NSR* must be able to identify phrases, and constraints expressing the main stress of words must be able to identify words. The same will hold for the edge constraints that I propose.

First, consider Dutch. Dutch compounds have initial stress, which can be expressed by an alignment constraint that – informally stated – aligns the head of a compound with a constituent at the left edge of the compound, cf. (23a). The initial stress of compounds can be overruled in embedded compounds by preferring the right edge of the compound. Let us assume *EdgeRight*, the mirror-image of *EdgeLeft* referring to the category C, dominating the alignment constraint *AlignLeft*.



- (23) a. ALIGNLEFT  
The most prominent syllable of the leftmost constituent in a compound C is the most prominent syllable of C.
- b. EDGERIGHT  
In a compound domain C, a subconstituent adjacent to the right edge of C is more prominent than a subconstituent that is not adjacent to one of the edges of C.
- c. EdgeRight >> AlignLeft

Word stress can be overruled too, but only if EdgeRight can be satisfied, implying that EdgeRight dominates MSR. Consider some crucial candidates of a left-branching compound in Dutch, in which MSR is irrelevant.

- (24) [[voet bal] veld]      EdgeRight >>      AlignLeft  
a. ( \*       . )      \*!  
   ( \*       . )  
   ( \* ) ( \* ) ( \* )  
   voet bal veld
- b. ( \*       . )  
   ( \*       . ) ( \* )  
   ( \* ) ( \* ) ( \* )  
   voet bal veld
- c. (       \*       . )      \*!  
   (       \*       ) ( \* )  
   ( \* ) ( \* ) ( \* )  
   voet bal veld
- d. (       \*       . )      \*!  
   (       \*       )  
   ( \* ) ( \* ) ( \* )  
   voet bal veld
- e. (       .       \* )      \*!  
   (       \*       ) ( \* )  
   ( \* ) ( \* ) ( \* )  
   voet bal veld

For this left-branching compound, candidate (24b) is the most optimal candidate, not violating any constraint. *veld*, a right-edge subconstituent, must be more prominent than the internal constituent *bal*, therefore, all other candidates violate EdgeRight: in (24d), because *veld* is less prominent, and in (24a), (24c) and (24e), because they are equally prominent.

For right-branching compounds, the same contour is selected, i.e. Dutch is not sensitive to branchingness in the compound:

- (25) [bad [hand doek]]      EdgeRight >>      AlignLeft  
a. ( \*       .       )      \*!  
   ( \* ) ( \*       . )  
   ( \* ) ( \* ) ( \* )  
   bad hand doek
- b. ( \*       .       )      \*  
   ( \* ) (       .       \* )  
   ( \* ) ( \* ) ( \* )  
   bad hand doek
- c. (       .       \*       . )      \*!  
   ( \* ) ( \*       . )  
   ( \* ) ( \* ) ( \* )  
   bad hand doek
- d. (       .       \*       )      \*!  
   ( \* ) (       .       \* )  
   ( \* ) ( \* ) ( \* )  
   bad hand doek

In *badhanddoek*, the right-edge constituent *doek* must be more prominent than the internal constituent *hand*, therefore (25a) and (25c) violate EdgeRight. The alignment constraint decides between the two remaining structures and selects (25b).

In English, branchingness plays a role in compound stress. A subconstituent that is not located at an edge can be more prominent than an edge constituent. Therefore, EdgeRight must play a minor role in English, if at all.

In a rule-based analysis, the different stressings of the examples in (19b) can be derived by assuming final word-extrametricity and End Rule (R). The End Rule can be replaced by an alignment constraint expressing final stress, cf. (26a). In OT (cf. Prince & Smolensky 1993), we have seen that extrametricality translates as a

constraint of the family NON-FINALITY. The first formulation of NON-FINALITY with respect to compounds that comes to mind is the one in (26b):

- (26) a. ALIGNRIGHT  
The most prominent syllable of the rightmost constituent in a compound C is the most prominent syllable of C.
- b. NON-FINALITY (preliminary version)  
No head of C is final in C.

There are two reasons to reject the formulation of the constraint in (26b). Firstly, it is not able to make the right choice between two relevant candidates of right-branching structures, as illustrated in (27):

- (27) a. (\* . . ) b. ( . \* )  
(\* ) (\* . ) (\* ) (\* . )  
(\* ) (\* ) (\* ) (\* ) (\* ) (\* )  
kitchen towel rack kitchen towel rack

The head of the entire compound is *towel rack*, which is the final constituent. (26) would consider (27a) to be more optimal than (27b).

Secondly, we have to account for the fact that English compounds are never adjusted and prefer flat patterns. Whereas in Dutch the right edge of a compound is preferably stressed, in English there is an absolute ban on final stressing within compounds. Let us assume the following constraint, dominating the alignment constraint:

- (28) a. NON-FINALITY (=NONFIN) (final version)  
A subconstituent adjacent to the right edge of C is not stressed.
- b. NONFIN >> AlignRight

Actually, NONFIN takes over the position and role of EdgeRight in Dutch. The two express contradicting properties: non-final and final stressing of a subconstituent. NONFIN still considers subconstituents, but it differs from the Edge-constraints in not comparing it with other (internal) subconstituents. Every subconstituent at the right edge in C that is stressed, violates the constraint. Therefore, it also applies in binary constituents and this is exactly what we need to

account for the different stressing in left- and right-branching compounds. Moreover, NONFIN can be held responsible for flattened patterns in English compounds. Consider the same pool of candidates seen in Dutch now for English compound structures.

- (29) [[kitchen towel] rack] NONFIN >> AlignRight
- a. (\* . )  
(\* . )  
(\* . ) (\* . ) (\* )  
kitchen towel rack \*\*
- b. (\* . )  
(\* . ) (\* )  
(\* . ) (\* . ) (\* )  
kitchen towel rack \*\*
- c. ( . \* )  
( . \* ) (\* )  
(\* . ) (\* . ) (\* )  
kitchen towel rack \*
- d. ( . \* )  
( . \* )  
(\* . ) (\* . ) (\* )  
kitchen towel rack \*
- e. ( . \* )  
( . \* ) (\* )  
(\* . ) (\* . ) (\* )  
kitchen towel rack \*!

In (29), two C-domains are present: *kitchen towel* in which *towel* must be unstressed, and *kitchen towel rack* in which the subconstituent *rack* must be unstressed. (29b) is rejected because *rack* is stressed. (29c) and (29e) violate NONFIN in both domains: *towel* and *rack* are both stressed. In (29d), NONFIN is violated in the subdomain *kitchen towel*. Whereas in Dutch, candidate (29b) would be selected, in English candidate (29a) wins, because this is the only one in which NONFIN is not violated. The lack of rhythmic alternation can entirely be attributed to this constraint, because this is the only difference with candidate (29a).

In the right-branching compound, we again have two domains, this time *towel rack* and *kitchen towel rack*. Both domains share the same subconstituent *rack*, which must be unstressed.

- (30) [kitchen [towel rack]]
- a. ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 kitchen towel rack
- b. ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 kitchen towel rack
- c. ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 kitchen towel rack
- d. ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 ( \* ) ( \* ) ( \* ) ( \* ) ( \* )  
 kitchen towel rack
- NONFIN >> AlignRight
- \*\*!
- \*!
- \*!

It is crucial that NonFIN considers subconstituents. Candidates (30b) and (30d) are rejected, because *rack* is stressed. The choice between (30a) and (30c) is made by the alignment constraint. (30c) wins because it violates this constraint only once. The combined influence of NonFIN and the alignment constraint is responsible for the difference with Dutch, which would prefer candidate (30b).

Finally, as noted above, word stress in English compounds is immovable. This can be accounted for through the domination of NonFIN by MSR. The constraint hierarchy MSR >> NonFIN prohibits both the rightward shift of word stress in English compounds (*law library* / \**law library*) and the leftward shift of stress in words with (exceptional) final main stress (*élection campaign* / \**élection campaign*) because MSR is violated fatally in both cases. Stress shift in English compounds is excluded regardless of the constituent structure of the individual compound members.

To conclude this section, we can attribute to NonFIN not only the lack of rhythmic alternation (i.e. non-adjustment) in English compounds as opposed to Dutch, but also the difference in stressing between English and Dutch. In rule-based analyses, these two aspects were unrelated facts.

5. Embedding of compounds in phrases

Thus far, we have established the following rankings for Dutch and English:

- (31) Dutch  
 Compounds: EdgeRight >> MSR, AlignLeft  
 Phrases: EdgeLeft >> MSR, NSR
- English  
 Compounds: MSR >> NonFIN >> AlignRight  
 Phrases: EdgeLeft >> MSR, NSR

It is crucial that the constraints can identify their relevant categories in bracketed grids. For instance, a construction like *Tom Paine Street Blues*, discussed in section 1, has the same left-branching structure as *thirty two twenty blues*, discussed in section 3. Their surface patterns, however, are not identical. The difference can be explained if we are able to refer to specific categories, as I will show below.

In the literature on prosodic phonology (among others Selkirk 1984; Nespor & Vogel 1986), it is proposed that there is a prosodic hierarchy. Somewhat simplified, we can say that prosodic words combine into minor phrases (or phonological phrases) and minor phrases combine into higher-level constituents (major phrases or intonational phrases). In principle, levels cannot be skipped, lower categories cannot dominate higher ones and dominating categories may not be identical with the category they dominate (i.e. non-recursivity). This would lead to the following type of representation of the surface pattern of the example in (32).

- (32) Ma P( ( \* )<sub>Ma P</sub>  
 Mi P( \* ) ( \* )<sub>Mi P</sub>  
 WD( \* ) ( \* )<sub>WD</sub>  
 [[twenty-two] pontoons]

The theory of the prosodic hierarchy demands that, when the constituent *thirty-two* is combined with *pontoons*, both share the same category, i.e. *pontoons* must be a minor phrase itself. If we adopt this view then EdgeLeft would consider the structure in (32) as optimal: in every P that is present, subconstituents at edges are stronger than internal subconstituents. With respect to the minor phrase *pontoons*, EdgeLeft has nothing to say: both subconstituents are lying at edges. The decision of which one of these subconstituents is more prominent

is entirely a matter of the set of constraints defining main stress of words.

With respect to compounds, McCarthy & Prince (1993) claim that recursion of the category "prosodic word" is possible. They note that the prosodic hierarchy expresses the domination relations among the prosodic constituents, but it does not express relations of immediate dominance, because there is no upper limit on the length of a prosodic word.

In what follows, I will refer to a prosodic word with *W*, to a minor or major phrase as *P* and to a compound as *C*, which is enough to illustrate the evaluation of candidates in which compounds are embedded in phrases.<sup>4</sup> The constraints in (31) can be integrated as in (33), now that we are able to identify categories in grid structure:

- (33) *Dutch*  
 EdgeLeft<sub>P</sub>, EdgeRight<sub>C</sub> >> MSR<sub>W</sub>, AlignLeft<sub>C</sub>, NSR<sub>P</sub>  
*English*  
 EdgeLeft<sub>P</sub> >> MSR<sub>W</sub> >> NonFin<sub>C</sub> >> AlignRight<sub>C</sub>, NSR<sub>P</sub>

Let us first consider the selection of the most optimal candidate for the left-branching construction *Tom Paine Street Blues* (MSR is left out in the evaluation; crucial categories are indicated):

- (34)  $\text{EdgeLeft}_P \gg \text{NonFin}_C \gg \text{AlignRight}_C, \text{NSR}_P$
- |    |                        |     |    |
|----|------------------------|-----|----|
| a. | P ( . )                | *   |    |
|    | C ( * . )              | (*) | *  |
|    | P ( . * )              | (*) |    |
|    | W (*) (*)              | (*) |    |
|    | Tom Paine Street Blues |     |    |
| b. | P ( . )                | *   |    |
|    | C ( * . )              | (*) | *  |
|    | P ( . * )              | (*) |    |
|    | W (*) (*)              | (*) |    |
|    | Tom Paine Street Blues |     |    |
| c. | P ( . )                | *   |    |
|    | C ( * . )              | (*) | *! |
|    | P ( . * )              | (*) | *  |
|    | W (*) (*)              | (*) | *  |
|    | Tom Paine Street Blues |     |    |

Two phrasal domains can be identified. In the maximal domain there are three subconstituents: *Tom Paine*, *Street* and *Blues*. *Street* is the only internal subconstituent and in all the candidates this constituent is less prominent than the edge constituents. Notice that it is crucial that EdgeLeft<sub>P</sub> only considers subconstituents one level down, otherwise *Tom* would be considered as an edge constituent since it is a word adjacent to the left edge of the entire phrase. The second domain is a name, which has phrasal stress: *Tom Paine*. Although its status as a phrase might be controversial, it does not violate EdgeLeft<sub>P</sub> under any circumstances: both subconstituents are edge constituents.<sup>5</sup> All the candidate structures satisfy EdgeLeft<sub>P</sub> in the phrasal domains. Candidate (34c) is rejected since it violates NonFin<sub>C</sub> in the compound domain. The remaining structures both violate AlignRight<sub>C</sub>, having a non-final head. The choice, then, is made by the NSR<sub>P</sub>, assuming that *Tom Paine* can be identified as a (lexicalized) phrase.<sup>6</sup> That this type of example does not surface with a "hammock pattern" can be attributed to the fact that a compound behaves as an island and is therefore immune to EdgeLeft<sub>P</sub>.

The most optimal candidate for the left-branching "pure" phrase is repeated in (35) with the addition of labels:

- (35) P ( . ) (\*)  
 P ( \* . ) (\*)  
 P ( . \* ) (\*)  
 W (\*) (\*) (\*) (\*)  
 thirty two twenty blues

Because all the domains are of the category *P*, EdgeLeft<sub>P</sub> is crucial and will select this output since it is the only candidate that does not violate this top-ranked constraint.

Finally, let us see how the different rankings for English and Dutch are responsible for selecting different output structures. The examples in (36) and (37) have the same branching structure (NSR is left out in the evaluation: it is satisfied in all candidates).

- (36)  $\text{EdgeLeft}_P \gg \text{MSR} \gg \text{NonFin}_C \gg \text{AlignRight}_P$
- |    |                        |     |   |
|----|------------------------|-----|---|
| a. | P ( . )                | *   |   |
|    | C ( * . )              | (*) | * |
|    | W (*) (*)              | (*) | * |
|    | law library newsletter |     |   |

- EdgeLeft<sub>P</sub> >> MSR >> NonFin<sub>C</sub> >> AlignRight<sub>P</sub>
- b. P ( . \* )  
 C ( \* . ) ( \* . ) \*  
 W ( \* ) ( . \* ) ( \* ) ( \* . ) \*  
 law library newsletter
- EdgeLeft<sub>P</sub> , EdgeRight<sub>C</sub> >> MSR , AlignLeft<sub>C</sub>
- (37) a. P ( . \* ) \*!  
 C ( \* . ) ( \* ) \*!  
 W ( \* ) ( . \* ) ( \* ) \*!  
 sport liefhebber Smeets
- ESP b. P ( . \* ) \*  
 C ( \* . ) ( \* ) \*  
 W ( \* ) ( . \* ) ( \* ) \*  
 sport liefhebber Smeets \*

In English, both MSR and NonFin<sub>C</sub> are violated in the second candidate; in Dutch this second candidate will be optimal since NonFin<sub>C</sub> is replaced by EdgeRight<sub>C</sub> and therefore will select the candidate that is ruled out in English.

## 6. Concluding remarks

In this paper, I have outlined an analysis of phrasal and compound patterns in English and Dutch within a constraint-based theory. Where phrases in these languages can be handled by the same constraints with the same ranking, there is a crucial difference in the treatment of compounds. In Dutch we have two edge constraints favoring stressed elements at edges of domains, while in English we have a constraint that explicitly excludes final stressing in compounds. The central position that this constraint occupies in the grammar of English is not only responsible for the position of main stress, but also for the fact that English has only left-edge prominence effects.

To conclude the discussion, some additional remarks can be made. First of all, I am aware of the fact that there are some complicated constructions and patterns (especially in Dutch) that cannot yet be handled completely with the set of constraints that I have introduced. However, my intention was to show that Edge constraints like the ones proposed in this article have to play a role in the grammar of Dutch and English. More research has to be carried out to determine whether or not other constraints have to be added to cover

the whole range of higher-level prominence patterns.

Secondly, it is predicted that all phrases show the left-edge effect. However, it has been observed that some words resist reallocation of main stress (cf. \**máron swéaters*, \**ðbese péople*, \**Móntana cówboy* but *sálocation ármý*). Some of these examples can probably be explained by Containment: EdgeLeft<sub>P</sub> cannot overrule lexical stresses in the input. However, because a rule-based analysis also struggles with these facts, I do not consider these facts specifically problematic for a constraint-based analysis.

Finally, the optionality of the phenomenon is almost completely neglected in this paper. One simple but naïve option is to deny the variation. The suggestion that I have made in this paper is that other factors interfere. For instance, the presence of a pitch accent can be held responsible for the selection of a different candidate as we have seen. More research has to be carried out if this point of view proves fruitful. The areas of variability and optionality in OT have been addressed by Kiparsky (1993), among others.

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## Notes

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- 1 In the literature (cf. Hayes 1984; Kager & Visch 1988; Visch 1989) it has been claimed that there are at least some cases for which the "shifted" pattern seems to be the most eurhythmic one, i.e. [*Fárrah* [*Fáwceit* *Májors*]/ [*T-shírt*]. Of course, judgements are delicate with respect to lower level degrees of stresses. There is at least one structural difference between (12b) and this one: *Fáwceit* is a prosodic word which happens to coincide with a (lefthand) syntactic boundary whereas *bamboo* is only a prosodic word. This difference is not (yet) formally expressible with the constraints that we assumed thus far. It is not my intention to discuss these complicated cases here.
  - 2 Sam Rosenthal pointed this out to me.
  - 3 The following statement seems to be true in phrases: "left-edge constituents are left-headed in P". However, this far more simple statement only covers, "shift"-cases. "Strengthening"-cases, like *three red shirts*, are neutral with respect to this statement. It does not force us to create additional structure on *three*, the-

refore, the more complicated formulation of the constraint is needed.  
<sup>4</sup> There are some questions left related to the category status of some constituents in prosodic structure, such as whether or not a compound that is embedded in a phrase is itself a phrase. If yes, then it should have its own domain in the grid because of the Faithfulness Condition. Moreover, what is the category of a word that is combined with a complex compound? In the cases to be discussed in this section, the status of these constituents makes no difference. In other cases it might, but I will leave this for further investigation in the future.  
<sup>5</sup> That a phrasal category can be embedded in a compound is not unusual, but a rather productive process (see for an extensive discussion Visch 1989: Appendix A).

<sup>6</sup> Notice that AlignRight<sub>C</sub> and NSR<sub>F</sub> are almost identical, both preferring the stressing of the rightmost constituent in a domain. This suggests that they might be collapsed.

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